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UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C.

EFFECT OF COVER ON SURFACE RUN-OFF AND EROSION IN THE LOESSIAL UPLANDS OF MISSISSIPPI

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CONTENTS

	Page
Introduction	1
Methods	2
Description and history of study areas	3
Analysis of rainfall records	5
Results of run-off and erosion measurements	8
Discussion of results	12
Summary	13
Literature cited	14

INTRODUCTION

The study described in this circular forms a part of a soil-erosion and run-off investigation begun by the Southern Forest Experiment Station in 1929 in the silt loam uplands east of the Mississippi River. This section (fig. 1), roughly 500 miles long and 35 miles to 100 wide, is characterized by widespread erosion of an especially destructive type and is considered one of the regions contributing most heavily to the silt and flood problems of the lower Mississippi River Valley. Bennett (*3*)[1] estimates that of the total 17,000,000 acres of land which the area comprises erosion has severely impoverished 4,500,000 acres and devastated some 1,800,000 acres. Sinclair (*7*) has described the extent of erosion and of damage resulting from soil washing in that portion of the area lying in the State of Mississippi. A description of watershed conditions in this section prepared by the Forest Service appears in a recent report to the Senate (*8, pp. 412–418, 1521–1523*).

Only a few detailed plot studies of run-off and erosion have been undertaken on forest lands. Lowdermilk (*4*) reports a study of run-off from burned and unburned plots in the chaparral forests of southern California in which the ratio of surface run-off from burned plots to that from unburned plots approximated 3.6:1. A similar study of run-off from scrub oak woodland in the red plains of Oklahoma was described by Bennett (*2*), who reported that run-off during May 1930 from an unburned plot amounted to 250 gallons per acre, while the corresponding loss from an adjacent burned plot was 27,600 gallons per acre.

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[1] Italic numbers in parentheses refer to Literature Cited, p. 14.

Studies of surface run-off and erosion from land of various cover and use classes in the silt loam uplands of Wisconsin were made by Bates and Zeasman (*1*) during the summer of 1929. Run-off from a number of hardwood forests on slopes averaging 36 percent averaged 2.8 percent of the summer rainfall, while that from grainfields, cornfields, seeded pastures, and fallow land averaged more than 25 percent.

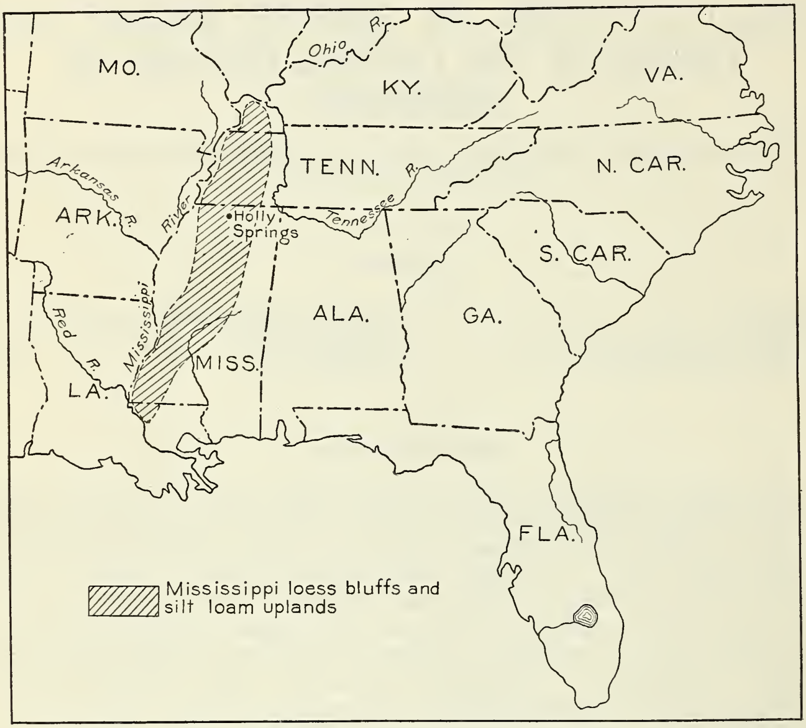

FIGURE 1.—Location of the Mississippi loessial uplands.

METHODS

A total of 11 plots was used in this study. Of these, 8 were used throughout the entire 2-year period, while the other 3 served as duplicates.

Study plots were established during the late summer of 1931 on areas near Holly Springs, Marshall County, northern Mississippi, differing as to cover type and as to land use. All plots were rectangular in shape, and were 3 by 12 feet in projectional dimensions.[2] All were laid out on a uniform 10-percent grade, the length of each plot paralleling the slope. Each plot was surrounded on three sides by a strip of galvanized iron 7 inches wide, which was sunk in the soil so that only 2 inches protruded above the surface and was made watertight at the corners. This prevented surface drainage onto the plot from adjoining areas. At the lower end of each plot a galvanized-iron tank was sunk flush with the surface, so as to receive all run-off and eroded material, and was securely anchored. This installation is shown in plate 1, *A*.

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[2] Larger plots could not be used because it was impossible to find areas larger than 3 by 12 feet that were strictly uniform as to conditions of cover, slope, and soil.

Run-off and eroded material were measured after each rain or series of rains. When the volume of run-off water in the tanks had been determined by depth measurements, the water was pumped out. The eroded material was then dipped from the tank and weighed, and samples were taken to determine the quantity of dry soil eroded. Rainfall was measured with standard rain gages, one of which was set up near each plot or pair of plots. Data on the intensity and duration of each rain were furnished by a recording rain gage, centrally located.

DESCRIPTION AND HISTORY OF STUDY AREAS

The soils on which the plots were established were identical in origin. To a depth of 10 to 15 inches they were derived from weathered loess, a wind-transported soil deposited in Pleistocene times. The loess was underlain by sedimentary materials of the upper coastal plain.[3] In the upper 1-foot section the soils possessed characteristics rather typical of those of the Memphis series and might be thus classified were it not for the shallowness of the loessial mantle. The soils on which plots were located varied somewhat in texture and other characters but, for the purposes of this study, were comparable, since they had a similar profile prior to cultivation or other treatment. In some cases the A horizon, which originally was about 6 inches in depth, had been reduced or entirely removed by erosion. A mechanical analysis [4] of composite soil samples from the plots showed that these soils contain a high percentage of silt and clay, especially in the upper 6 inches. At that level the silt-clay content ranges from 53 to 90 percent. At 6 to 20 inches the soils contain less silt and greater quantities of clay and sand.

Duplicate plots were established in (1) a cultivated field, (2) a barren abandoned field, (3) a mature oak forest, and (4) an abandoned field with a cover of native grass. Single plots were established in (5) a 21-year-old plantation of black locust and Osage-orange, (6) a scrub oak woodland, and (7) a Bermuda grass pasture. A description of these areas follows:

The cultivated field (pl. 1, *B*), which was in corn when the plots were established but was planted to cotton during the study period, represents the more productive portions of the upland region. It was cleared of oak forest in 1927. About 4 to 5 inches of the A horizon was still intact at the beginning of the study. This layer consisted of gray silt loam containing slightly more than 1 percent of organic matter. During the study period the herbaceous ground cover has consisted chiefly of crabgrass (*Syntherisma sanguinale*).

The first-mentioned abandoned field, formerly in cotton, has not been cultivated since 1924. At the time when the plots were established, most of it supported a scattered growth of scrub oak and persimmon with a ground cover of native grasses; the slope on which the plots were located, however, had no plant cover other than a few dwarfed specimens of poverty grass (*Aristida dichotoma*). Erosion had entirely removed the A horizon, exposing a compact yellow silty clay loam subsoil almost devoid of vegetable matter.

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[3] Holly Springs sands of the Wilcox formation (Eocene period).

[4] By the Bureau of Chemistry and Soils, U. S. Department of Agriculture.

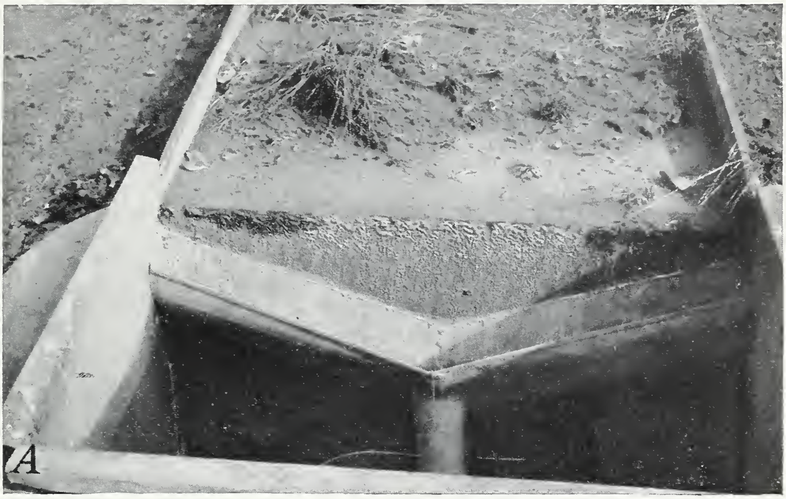
The abandoned field in which the native grass plots were established has been out of cultivation since 1908 or longer. The grass cover consists principally of the so-called broomsedges *Andropogon scoparius*, *A. ternarius*, *A. virginicus*, and *A. elliottii*, which prevailingly compose the grass cover of abandoned and waste areas of the region. The grass on the plots has an average density of more than 0.9. A dense "rough" (matted dead foliage) indicated that the field had not been burned over for at least 4 years before the study began. The soil of the A horizon, which is only 3 inches in depth, is a gray silt loam containing 2 percent of organic matter.

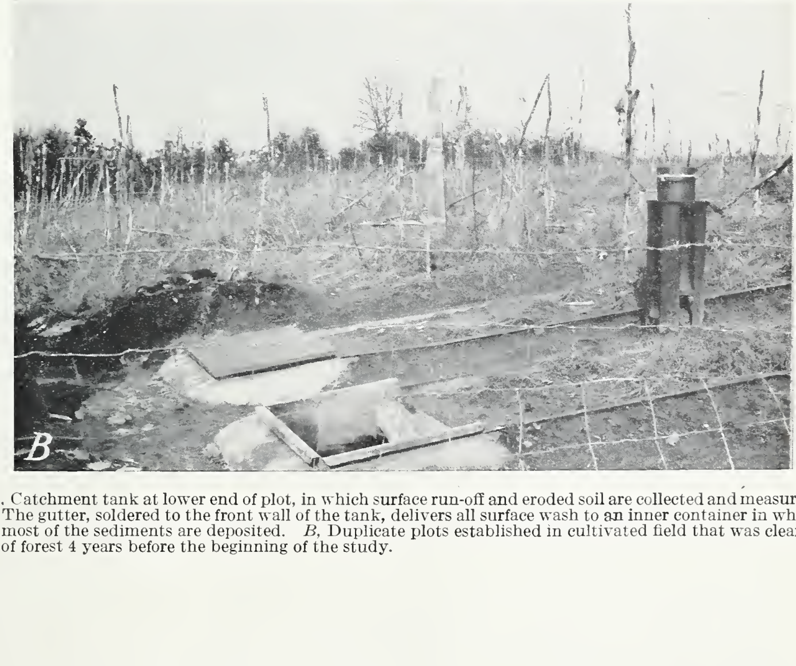
The Bermuda grass (*Capriola dactylon*) pasture was formerly badly eroded as a result of cultivation and abandonment. About 1913 the gullies were filled by means of a plow and a drag scraper, the slopes terraced, and Bermuda grass sod planted. The plot has a complete grass cover. The upper 4-inch layer of soil, representing the A horizon, is a gray silt loam containing slightly less than 2 percent of organic matter.

The mature oak forest area represents cover and soil conditions such as existed on the other areas prior to cultivation or other treatment. The forest is made up of trees approximately 75 to 100 years years old, and averages about 175 trees per acre from 5 to 28 inches in breast-height diameter. It consists chiefly of southern red oak (*Quercus rubra*), post oak (*Q. stellata*), and black oak (*Q. velutina*), with such minor species as dogwood (*Cornus florida*) and persimmon (*Diospyros virginiana*). Southern red oak makes up 75 percent of the stand. During the growing season the density of the crown canopy above the plots is approximately 0.6. This forest is fairly typical of the remaining bodies of upland hardwood forest in the region. It differs from the average mainly in not having been burned over since at least 7 years prior to the beginning of the study. Underbrush and herbaceous ground cover are almost entirely lacking owing to light grazing, chiefly by hogs. The duff (pl. 2, *A*) averages 1½ inches in depth and is underlain by one-half inch of black leaf mold. The soil of the A horizon, which is about 6 inches in depth, is a dark gray silt loam, loose and granular, containing 3 percent organic matter.

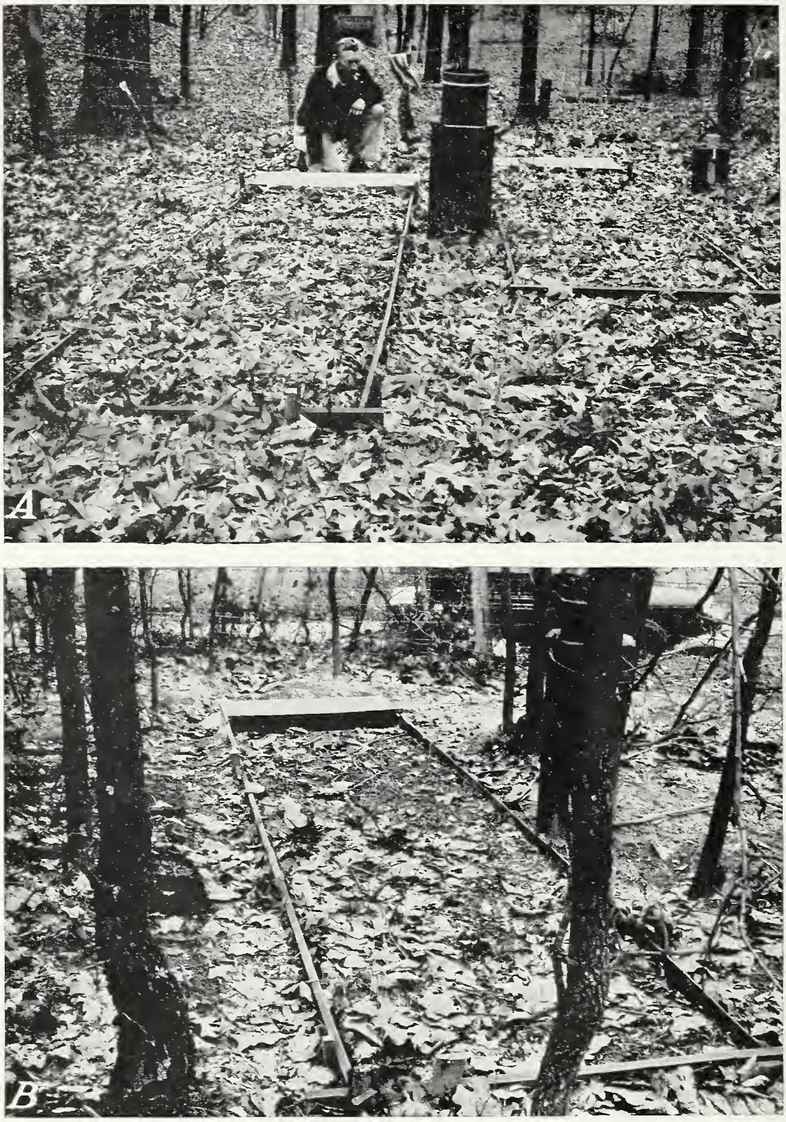
The scrub oak woodland represents extensive stands of second-growth woodland in this section that are inferior in quality as a result of severe cutting, annual fires, and other abuses. The stand consists of blackjack oak (*Q. marilandica*) with some post oak, persimmon, dogwood, and sassafras (*Sassafras variifolium*). It is dense, containing about 1,500 stems per acre. The trees range from 1 to 3 inches in breast-height diameter and from 10 to 20 feet in height. A blackjack oak 24 inches in breast-height diameter and 49 feet high overtops the oak thicket in which the plot is located. The canopy when in full leaf has an estimated average density of 0.8. Small quantities of leaves, twigs, and other debris compose the only ground cover, and mineral soil is exposed in many places (pl. 2, *B*). The soil of the A horizon, which is 6 inches in depth, is a gray to light-brown silt loam that, except in the upper one-quarter inch, contains little humus.

The plantation site (pl. 3, *A*) was formerly a gullied and sheet-eroded old field. Seedlings of black locust (*Robinia pseudoacacia*)





A, Catchment tank at lower end of plot, in which surface run-off and eroded soil are collected and measured. The gutter, soldered to the front wall of the tank, delivers all surface wash to an inner container in which most of the sediments are deposited. *B*, Duplicate plots established in cultivated field that was cleared of forest 4 years before the beginning of the study.



A, Oak forest plots, with heavy ground cover of leaf litter and duff indicating complete protection from fire for several years; *B,* scrub oak plot, with relatively scanty accumulation of leaf litter.

and Osage-orange (*Toxylon pomiferum*) were planted in alternate rows in 1910 to control erosion and reclaim the land. The trees were originally spaced 6 feet apart, but the stand has been reduced from time to time by removal of the larger trees for fence posts. The crown canopy when in full leaf has an average density of about 0.9. Leaf litter is scant, but a ground cover of weeds, grasses, and tree sprouts is well established and is more than 50 percent complete (pl. 3, *B*). The area has suffered somewhat from light fires and from winter grazing; and the soil, a gray silty clay loam in the upper 5 inches, is rather compacted. Dark leaf mold composes the upper one-quarter inch of soil.

ANALYSIS OF RAINFALL RECORDS

Rainfall [5] during the 2-year study period was above normal, totaling 130.70 inches, or 25.08 inches (23.7 percent) more than the average for the locality. Normal rainfall was exceeded by 20.07 inches during the first year of the study and by 5.01 inches during the second.

The distribution of rainfall by months during each of the 2 years is compared in figure 2 with the mean distribution by months for the 46 years ended with September 1933. Rainfall was especially heavy in December and January of the first year and in February of the second year. Rainfall during December 1931 totaled 14.05 inches, an excess of 8.71 inches. A total of 38.41 inches of rain fell during the period November 1931–February 1932, inclusive, which was more than 100 percent above normal. During the second year of the study rainfall was 26 percent above normal for the period

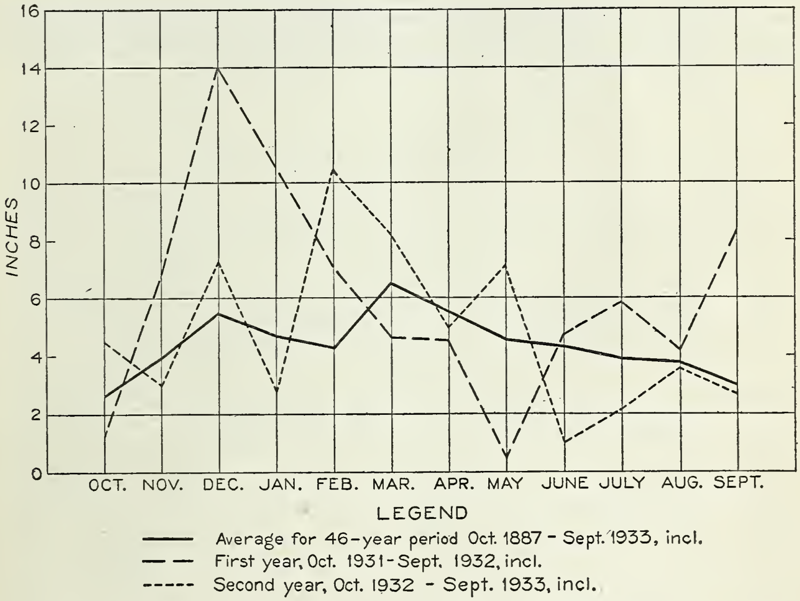


FIGURE 2.—Total rainfall, by months, during each of the 2 years of the study period, in comparison with the average for the 46-year period October 1887–September 1933, inclusive. (Based on records made in study and on U. S. Weather Bureau records of rainfall at Holly Springs, Miss.)

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[5] In this region precipitation occurs almost exclusively as rainfall. Annual snowfall totals usually only a few inches.

November–March, inclusive, in spite of monthly deficiences in November and January. Excess of rainfall during the winter months tends to give rise to especially critical erosion conditions, because during the winter cultivated soils are more exposed to the elements and plant cover is least protective.

Table 1 shows for each month of the study period the number of rains and the total rainfall, and classifies the rains, by months, according to quantity of precipitation. During the 2 years there were 103 rains,[6] varying in quantity of precipitation from 0.03 inch to 5.32 inches.

A number of the heavier rains were of comparatively short duration. On 16 occasions a rain of from 2 to 4.17 inches fell in less than 24 hours. On January 12, 1932, a 4.17-inch rain fell in 14 hours. On 15 occasions 0.50 to 0.80 inch of rain fell in 15 minutes, and on 4 occasions 0.85 to 1 inch of rain fell in 30 minutes. In one rain totaling 2.44 inches, 1.30 inches fell during 3 periods of only a few minutes each.

Of the total 2 years' precipitation 28 percent occurred as torrential rainfall and 20 percent occurred as rainfall of moderate intensity.[7]

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[6] This total is the number of individual rains or series of rains for which run-off and erosion records were obtained. Records were obtained for individual storms when possible, but sometimes a single record had to suffice for a succession of rains extending over several days; of the 103 records, 82 are for single storms.

[7] Rainfall was classified as follows: Torrential, at a rate of more than 0.75 inch per hour; moderate, at a rate of 0.40 to 0.75 inch per hour; gentle, at a rate of less than 0.40 inch per hour.

TABLE 1.—*Number of rains and quantity and distribution of rainfall, by months, during the 2-year study period*

Month	Rains or series of rains [1]	Total rainfall	Deviation from 46-year average [2]	Rains classified according to quantity of precipitation									
				Less than 0.25 inch		0.25 to 0.99 inch		1 to 1.99 inches		2 to 2.99 inches		3 inches or more	
	Number	*Inches*	*Inches*	*Number*	*Inches*	*Number*	*Inches*	*Number*	*Inches*	*Number*	*Inches*	*Number*	*Inches*
FIRST YEAR—OCTOBER 1931 TO SEPTEMBER 1932, INCLUSIVE													
October	2	1.37	−1.27	1	0.05			1	1.32				
November	5	6.89	+3.04	1	.23			3	4.54	1	2.12		
December	9	14.05	+8.71	1	.18	2	1.01	4	5.59	1	2.11	1	5.16
January	8	10.47	+5.70			5	2.46	1	1.67	1	2.17	1	4.17
February	6	7.00	+2.73	2	.29	1	.28	1	1.00	1	2.04	1	3.39
March	5	4.64	−1.90	2	.25	1	.86	2	3.53				
April	5	4.59	−.88	1	.03	2	1.29	1	1.09	1	2.18		
May	4	.57	−3.96	4	.57								
June	4	4.82	+.49			3	2.02			1	2.80		
July	2	5.99	+2.03							1	2.51	1	3.48
August	4	4.17	+.31			2	1.27	2	2.90				
September	3	8.11	+5.07							2	4.97	1	3.14
Total	57	72.67	+20.07	12	1.60	16	9.19	15	21.64	9	20.90	5	19.34
SECOND YEAR—OCTOBER 1932 TO SEPTEMBER 1933, INCLUSIVE													
October	5	4.59	+1.97	1	0.21	3	1.94			1	2.44		
November	4	3.02	−.92			3	1.61	1	1.41				
December	5	7.34	+1.80	1	.14	1	.34	2	2.89			1	3.97
January	4	2.75	−2.10	1	.14	2	1.41	1	1.20				
February	3	10.37	+6.11					1	1.55			2	8.82
March	4	8.23	+1.68			2	.57					2	7.66
April	4	4.98	−.55					4	4.98				
May	3	7.07	+2.51			1	.75	1	1.00			1	5.32
June	2	1.16	−3.21			2	1.16						
July	3	2.32	−1.56			3	2.32						
August	5	3.53	−.31	1	.18	3	1.96	1	1.39				
September	4	2.67	−.41			4	2.67						
Total	46	58.03	+5.01	4	.67	24	14.73	11	14.42	1	2.44	6	25.77
2-YEAR PERIOD													
Total	103	130.70	+25.08	16	2.27	40	23.92	26	36.06	10	23.34	11	45.11

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[1] Of the 103 records, 82 are for single storms.

[2] Averages for 46 years based on U. S. Weather Bureau records of precipitation at Holly Springs, Miss., during the period October 1887–September 1933.

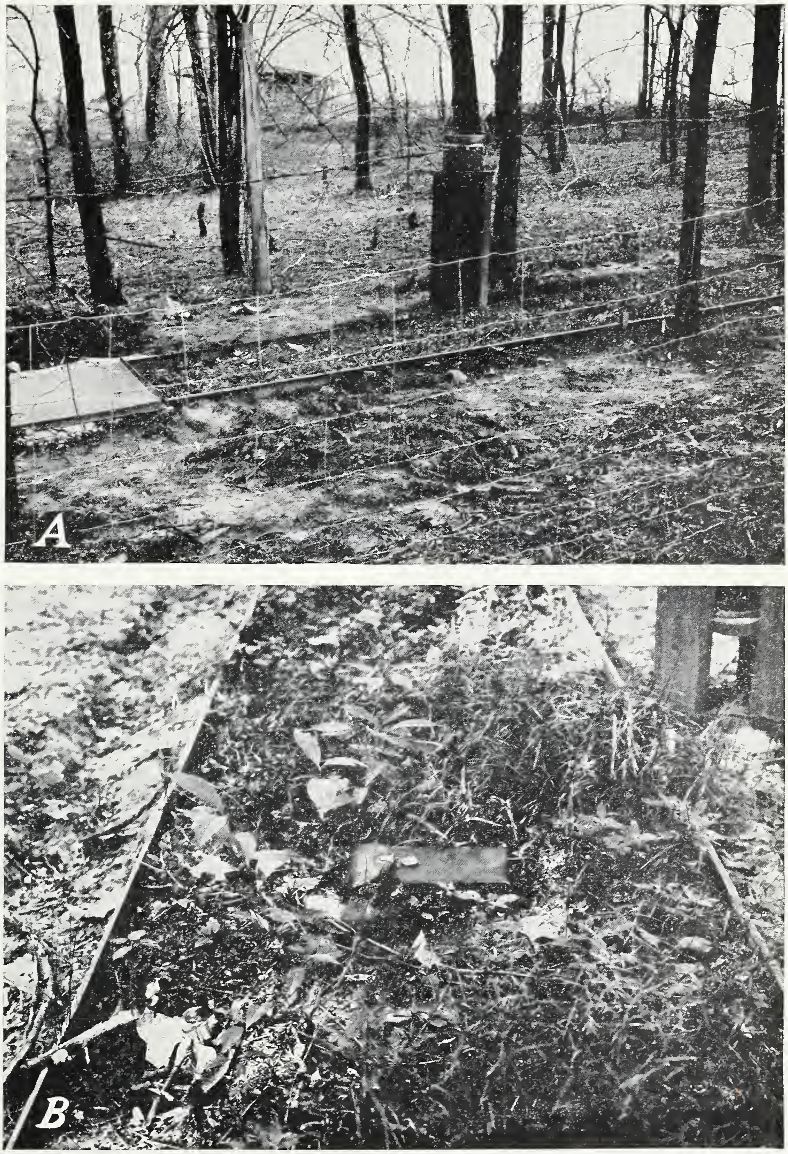
RESULTS OF RUN-OFF AND EROSION MEASUREMENTS

The frequency with which measurable surface run-off and erosion from the various plots resulted from the 103 rains is indicated in figure 3. As the figure shows, the number of rains that caused run-off and erosion from the cultivated and barren plots was much greater than the number of rains that had this effect on plots with a plant cover. A total of 90 rains caused run-off from the barren plots and from the cultivated plot on which the rows paralleled the slope, and of these 89 caused erosion from the former and 87 from the latter. Almost as many rains produced run-off and erosion from the cultivated plot on which the rows followed the contour. From the scrub oak plot 54 rains caused run-off, and of these 38 caused erosion. Rains thus resulting on the forest plantation plot numbered 38 and 31, respectively. Run-off from the Bermuda grass plot was caused by 33 rains, but only 14 of these removed soil from the plot. Soil and water losses were least frequent on the broomsedge and oak forest plots, run-off being caused by only 29 rains on the former and by only 32 rains on the latter. For a number of hours after certain rains small quantities of water seeped into the catchment tank of each of the forest plots from saturated leaf litter which overhung the lip of the tank. This slow seepage possessed little or no power to erode. As is shown in figure 3, out of 32 rains causing run-off only 8 caused erosion from the forest plots, whereas out of 29 rains causing run-off 16 caused erosion from the broomsedge plots.

Data on the minimum quantities of rainfall that caused run-off from the various plots, shown in figure 4, corroborate the data on run-off and erosion frequencies. Rains of only 0.13 and 0.14 inch caused run-off from the barren and cultivated plots, respectively; but only when rainfall totaled as much as 0.77 inch did surface waters wash from broomsedge and oak forest plots. A rain of 0.62 inch was the lightest, causing run-off from the forest plantation and Bermuda grass plots, and the minimum rain causing run-off from the scrub oak plot was 0.27 inch.

Marked differences were found among the various plots as to the percentage of precipitation in individual storms that ran off. These differences are indicated in figure 5, which shows for each plot or pair of plots the maximum percentage of rainfall that ran off. Maximum run-off for a single rain from the two cultivated plots amounted to 96 and 77 percent of the rainfall, respectively, and the maximum from the barren old-field plots amounted to 88 percent. Run-off from the cultivated plot on which the rows paralleled the slope exceeded 50 percent of the rainfall in 42 of the 103 rains, and exceeded 75 percent in 13 rains. Run-off from the barren old-field plots amounted to more than 50 percent of the rainfall in 30 rains, but on only three occasions did it exceed 75 percent. Run-off from the plots having a plant cover was comparatively small. During no storm did run-off from the oak forest plots exceed 3 percent of the rainfall, and the maximum run-off from plots having a broomsedge cover was only 5 percent. Maximum run-off from a single storm was 9 percent for the forest plantation plot, 21 percent for the Bermuda grass plot, and 33 percent for the scrub oak plot.

Run-off data for two individual storms clearly demonstrate that, under conditions comparable to those of the study, the ability of



A, Open stand of planted black locust and Osage-orange in which one of the study plots was located (winter aspect). Formerly an eroded abandoned field, the site has been reclaimed. *B*, Herbaceous cover on the plantation plot (midsummer aspect).

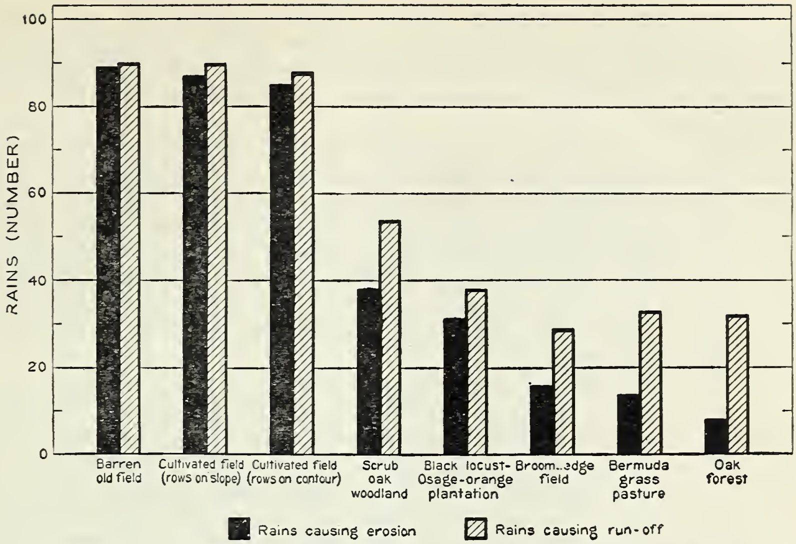


FIGURE 3.—Number of rains, out of a total of 103, that caused run-off and erosion from each plot or pair of plots.

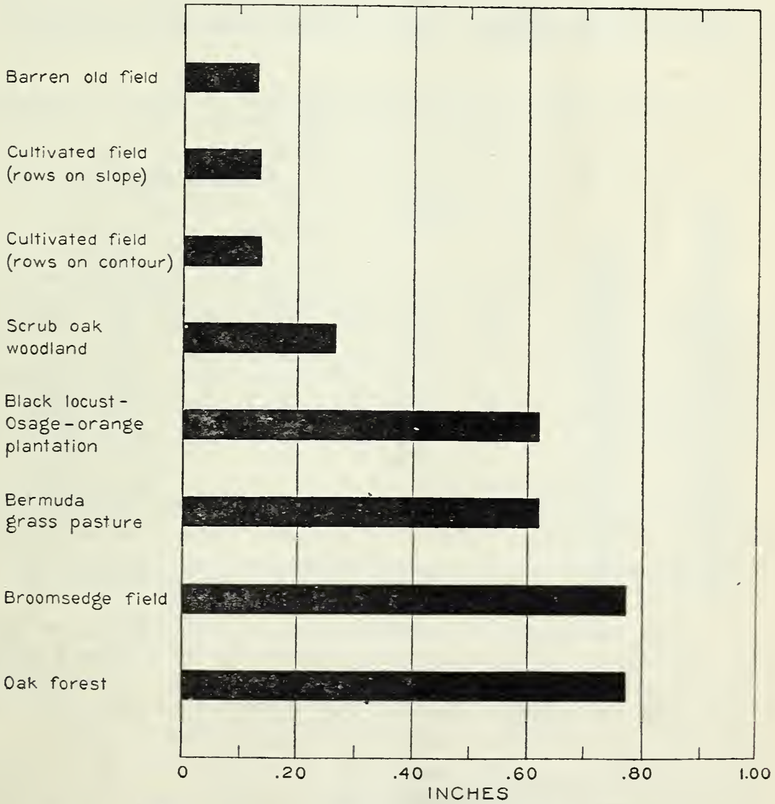


FIGURE 4.—Minimum quantity of rainfall causing run-off from each plot or pair of plots.

oak forest and broomsedge areas to absorb practically all rainfall holds even during extremely heavy rains. This is brought out in figure 6, which shows, for both storms, cumulative rainfall and comparative run-off from the oak forest, broomsedge, cultivated, and barren plots.

Storm no. 1, with a total rainfall of 4.05 inches,[8] was the major storm of a series of heavy rains that caused a disastrous flood in the Tallahatchie-Yazoo River Basin during January 1932 (*6*). This rain was only moderately intense, but continued for 14 hours. Storm no. 2 (3.78 inches) is representative of heavy rains occurring on June 30 and July 1 that resulted in a flood by which lowland crops were damaged to the extent of $20,000 (*9*). The latter storm was characterized by high intensities; twice during its progress, 0.75 inch of rain fell in 30 minutes.

Of the 4.05 inches of rain falling in storm no. 1, 3.75 inches ran off the surface of the cultivated plots and 3.29 inches ran off the barren plots, whereas but 0.08 inch and a trace more than 0.08 inch ran off the surfaces of the forest plots and the broomsedge plots, respectively. In storm no. 2, run-off from oak forest and broomsedge areas amounted to only 0.04 and 0.07 inch, respectively, in contrast with 2.89 inches from the cultivated field and 2.87 inches from barren abandoned land.[9]

Total run-off in relation to precipitation during the 2-year period is perhaps the best basis for comparing the absorptive capacities of the different land classes. Data on this point are summarized in table 2.

TABLE 2.—*Total surface run-off and water absorption in relation to precipitation during the 2-year study period*

Plot	Rains[1]	Total precipitation[1]	Quantity of rainfall that—					
			Was absorbed			Ran off		
	Number	*Inches*	*Inches*	*Cubic feet per acre*	*Percent*	*Inches*	*Cubic feet per acre*	*Percent*
Oak forest[2]	103	134.21	133.18	483,443	99.23	1.03	3,739	0.77
Broomsedge field[3]	103	126.50	125.12	454,186	98.91	1.38	5,009	1.09
Black locust-Osage-orange plantation	97	112.05	109.85	398,756	98.04	2.20	7,986	1.96
Bermuda grass pasture	92	105.66	101.68	369,098	96.23	3.98	14,447	3.77
Scrub-oak woodland	102	127.54	117.52	426,598	92.14	10.02	36,373	7.86
Barren abandoned land[3]	103	129.21	67.51	245,061	52.25	61.70	223,971	47.75
Cultivated land (cotton):								
Rows on contour	103	131.38	69.68	252,938	53.04	61.70	223,971	46.96
Rows on slope	99	126.89	53.04	192,535	41.80	73.85	268,076	58.20

[1] Differences shown are due to the fact that on 4 plots experimental conditions were seriously disturbed during the first 3 months of the study by the vertical displacement of improperly anchored catchment tanks caused by a few heavy rains, data for these storms being omitted because of their incompleteness or inaccuracy.

[2] Run-off and erosion data based on average of duplicate plots for the first 6 months of the study.

[3] Run-off and erosion data based on average of duplicate plots for the first 14 months of the study.

From the standpoint of water control and utilization, the significance of these run-off data is clearly shown by the contrast between the total surface water run-off per acre in 2 years of less than 4,000 cubic feet in oak forest and of 268,000 cubic feet on cultivated land.

Soil losses for the 2-year period are summarized in table 3.

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[8] Quantity of rainfall registered by recording rain gage. The average quantity caught in all rain gages on the study area, as is shown in table 1, was 4.17 inches.

[9] In storm no. 2 the quantity of rain falling on the forest plots was slightly (8 percent) less than that falling on the other areas.

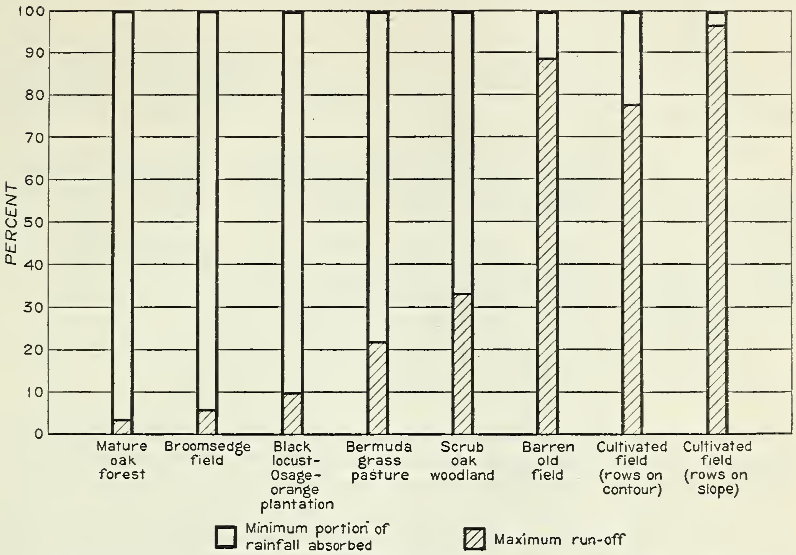

FIGURE 5.—Maximum percentages of rainfall that ran off the various plots during a single rain.

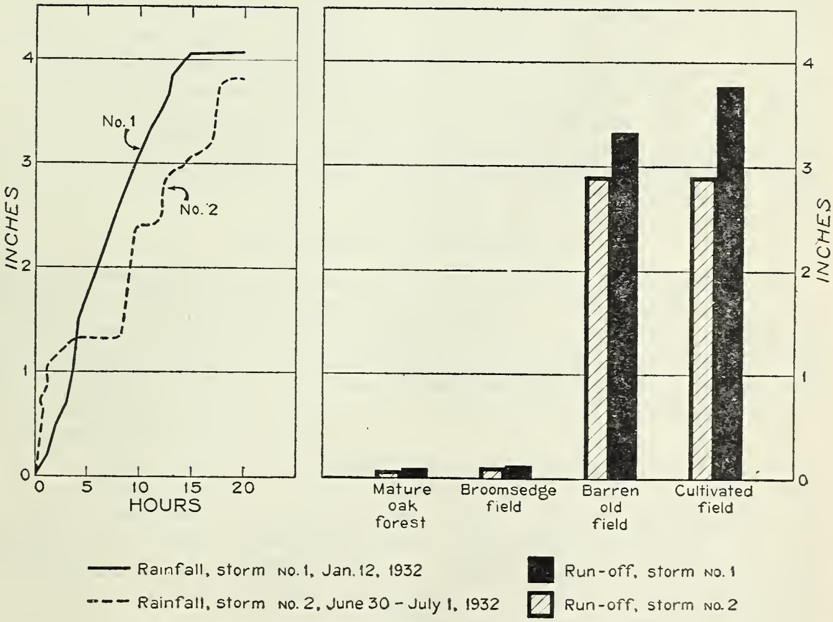

FIGURE 6.—Run-off, during two flood-producing rains, from bare plots and from plots having a plant cover.

TABLE 3.—*Soil erosion during the 2-year study period*

Plot	Total rainfall	Total run-off	Soil lost—			Relative quantities[1] of soil eroded	Rainfall required to erode 1 pound of soil per plot	Surface soil eroded	Years required at existing rate to erode 6 inches of topsoil
			Per plot	Per acre					
	Inches	*Inches*	*Pounds*	*Pounds*	*Tons*		*Inches*	*Inches*	*Number*
Oak forest	134. 21	1. 03	0. 075	91	0. 05	1	1, 789. 47	0. 0003	40, 000
Broomsedge field	126. 50	1. 38	. 305	369	. 18	4	414. 75	. 0011	10, 909
Black locust–Osage-orange plantation	112. 05	2. 20	1. 676	2, 028	1. 01	22	66. 86	. 0062	1, 935
Bermuda grass pasture	105. 66	3. 98	. 311	376	. 19	4	339. 74	. 0012	10, 000
Scrub-oak woodland	127. 54	10. 02	1. 089	1, 318	. 66	15	117. 12	. 0040	3, 000
Barren abandoned land	129. 21	61. 70	263. 961	319, 393	159. 70	3, 519	. 49	. 9776	12
Cultivated land (cotton):									
Rows on contour	131. 38	61. 70	114. 600	138, 666	69. 33	1, 528	1. 15	. 4244	28
Rows on slope	126. 89	73. 85	322. 472	390, 191	195. 10	4, 300	. 39	1. 1943	10

[1] In terms of the minimum quantity of soil eroded from any plot.

The soil loss from the black locust plantation was undoubtedly smaller than the data indicate; disturbances on this plot during the first 5 months of the study caused abnormal erosion, as is indicated by the fact that almost 50 percent of the total soil loss occurred during that period. Soil losses from the barren and cultivated plots were enormous, and were proportionate with the run-off from these plots.

The ratio of the soil lost from the two cultivated plots to that lost from each of the oak forest plots was 4,300 :1 and 1,528 :1. The barren plots lost 3,519 times as much soil as did the forest plots. The erosion rate during the 2-year period indicates that the enormous rainfall of 1,789 inches would be required to erode a pound of soil from a forest plot, but that less than one-half inch of rainfall is required to erode that quantity of soil from a barren plot or from a cultivated plot with rows on a slope. The stability of the soils having a plant cover is further illustrated by a calculation as to the number of years needed to erode the upper 6 inches of surface soil under the different systems of land use.

DISCUSSION OF RESULTS

The outstanding differences in the quantities of run-off from bare and vegetation-covered soils are significant in relation to stream-flow and flood problems, since flashy surface run-off composes the bulk of flood volume. During the 2-year period, the indicated run-off from an acre of cultivated land totaled 6 acre-feet, while run-off from an acre of forest land amounted to but little more than 1 acre-inch.

The ability of soils having a forest or grass cover to absorb practically all the rainfall demonstrates that such vegetation is an invaluable ally in the storage and retention of water that otherwise would form destructive surface flow. In view of Lowdermilk's findings (*4*, *5*), it appears probable that forest and grass cover exert almost their maximum effect on soil absorptiveness in the silt loam uplands of Mississippi, a section of fine-textured surface soils underlain by strata having great storage capacity.

Rainfall absorbed from the surface is not necessarily long delayed in reaching the streams; the delay is conditioned by several factors, especially the structure and character of the soil and of underlying materials. In this section, however, there is every reason to believe, rainfall once absorbed at the surface is sent deeply into the soil mass and is too long delayed in its appearance as seepage to figure conspicuously in flood stages. The upper soil layers are underlain largely by pervious deposits hundreds of feet deep. The silt and clay loams composing the upper soil horizons are themselves capable of retaining fairly large quantities of rainfall, according to observations made in road cuts and gully exposures after single rains. In such places, in which the depth of penetration by percolating water can be traced, invariably water appears as slow, lateral seepage for days after the heavy rains.

The huge soil losses from cultivated and other bare lands are indicative of the hazards involved in converting even moderate slopes, in the silt loam uplands of Mississippi, from forests to a bare-land type of agriculture. Although rainfall was abnormally abundant during the study period it is believed that the soil-loss figures are conservative, inasmuch as the gradient of the plots was moderate, their slopes were uniform, and their length was slight. These data substantiate earlier observations to the effect that the cultivable life of such upland soils ranges from 5 to 20 years only. It is doubtful that such hasty exploitation of these soils, which required ages of weathering to produce, adds much to the economic well-being of the landowner; obviously, it does not conduce to public welfare.

That forestry, pasture development, and the production of forage cover crops are types of land management deserving wider usage is also implied by the results of this study. It appears probable that on land having a plant cover of any of the types studied, the rate at which erosion is occurring is well within that at which soil is being formed by natural processes.

The study has disclosed evidence on several points relating to forest management. The data indicate that an inferior cover of scrub oak possesses distinct value for the protection of watersheds. They bring out also the extent to which the protective efficiency of forest cover can be reduced by annual fires and other abuses. Thus the scrub oak stand, which has replaced old-growth oak forest, permitted a soil loss 15 times as great as that permitted by normal forest cover and a rainfall loss by direct run-off 10 times as great as that permitted by such cover. A cover of black locust and Osage-orange, established less than 23 years previously, was found to have converted an eroded abandoned field into a stable site capable of absorbing 98 percent of the rainfall. Analyses of the soil of the planted area showed 3 percent of organic matter in the upper 6-inch layer, as great a proportion as occurs in the corresponding layer of virgin soil under oak forest.

SUMMARY

A study of surface run-off and soil erosion from comparable soils representing seven combinations of cover type and land use was carried on for 2 years (October 1931–September 1933, inclusive) at Holly Springs, in the loessial uplands of Mississippi. Measurements were made from small plots laid out on areas having a uniform 10-percent slope.

Rainfall during the 2 years totaled 130.70 inches, or 25 percent more than normal, occurring as 103 rains (or series of rains) of from

0.03 to 5.32 inches each. About 28 percent of the precipitation occurred as torrential rainfall, and 20 percent as rains of moderate intensity.

For a plot in a cultivated cotton field in which the rows paralleled the slope, surface run-off amounted during the 2 years to 58 percent of the total precipitation and in individual rains amounted to as much as 96 percent of the precipitation. On this plot the rate of soil erosion exceeded 195 tons per acre for the 2 years. For a cultivated cotton field in which the rows paralleled the contour, run-off totaled 47 percent of total precipitation and soil eroded during the 2 years totaled 69 tons per acre.

From barren plots in an old field there occurred during the 2 years a total run-off amounting to 48 percent of the rainfall, and erosion totaling nearly 160 tons per acre.

In the 2 years, the run-off from unburned broomsedge plots in an old field amounted to only slightly more than 1 percent of the rainfall, and that from oak forest to less than 1 percent. During no rain did run-off from land of these two classes exceed 5.05 and 3.10 percent of the rainfall, respectively. Erosion from such lands was almost negligible; the quantity of soil washed from each forest plot was to the quantity lost from one cultivated plot as 1 is to 4,300.

Total run-off and erosion from plots in a plantation of black locust and Osage-orange, a Bermuda grass pasture, and scrub oak woodland were somewhat larger than these but were very much smaller than those from barren or cultivated land.

The results of the study are particularly valuable in giving a comparison of surface run-off and erosion losses for different types of cover and in indicating the approximate losses that might occur on larger areas or watersheds where the water tends to concentrate into streams.

Because soils having a cover of vegetation absorbed practically all the rainfall, including that of extremely hard rains, and because the soils of the section possess great storage capacity, the general conclusion reached is that in the loessial uplands of Mississippi a plant cover, in addition to preventing abnormal erosion, is of tremendous value in flood control and stream-flow regulation.

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U. S. GOVERNMENT PRINTING OFFICE: 1935

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